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Guidelines for Line-Oriented Flight Training

Volume I

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Proceedings of a NASA/Industry Workshop
held at NASA Ames Research Center
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PREFACE

Line-Oriented Flight Training (LOFT) is a developing training technology which synthesizes high-fidelity aircraft simulation and high-fidelity line-operations simulation to provide realistic, dynamic pilot training in a simulated line environment. LOFT is an augmentation of existing pilot training which concentrates upon command, leadership, and resource management skills.

This report, based on a NASA/Industry workshop held in January, 1981, is designed to serve as a handbook for LOFT users. In addition to background information, guidelines are presented for designing LOFT scenarios, conducting real-time LOFT operations, pilot debriefing, and instructor qualification and training. The final chapter addresses other uses of LOFT and line-operations (or full-mission) simulation.

A companion volume (Volume II) is intended to serve as a sourcebook of additional, useful information on LOFT. Included therein are papers by NASA and industry representatives describing the development of LOFT and the various approaches taken to it. Also included are selected segments of the discussion transcripts, and questions and answers from the January workshop.

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CHAPTER I: INTRODUCTION AND BACKGROUND

Description of the NASA/Industry Workshop on LOFT

Line-Oriented Flight Training (LOFT) is an instructional technology still under development. In order to conduct a thorough review of the concept and the accumulated experience with it, the Federal Aviation Administration (FAA) and industry representatives requested that the National Aeronautics and Space Administration (NASA) organize and conduct a workshop to address various conceptual and practical issues related to LOFT. Since one of the important functions of the NASA aviation human factors program is to foster discussion and the exchange of experience, data, and views within the industry, NASA agreed to conduct such a workshop.

The NASA/Industry workshop convened a broadly representative group of airline management, pilots, flight engineers, and government personnel to review various approaches taken to LOFT by air carriers and their experiences with it. In view of the fact that LOFT under Advisory Circular 120-35 has not met with universal acceptance among airlines, it was essential to include representatives from those airlines as well, so that all of the significant issues would be fully and fairly addressed.

It was apparent that one useful product of the workshop could be the development of a set of guidelines for implementing and conducting LOFT. To be useful, these guidelines had to be devised so that differences in aircraft fleets, crews, routes, and other factors could be accommodated. LOFT is not in itself a specific training program; rather, it is the application of certain simulator and training technology to the development of aircrew training programs. The objective, then, was to formulate guidelines that could be used by any organization or carrier in the development of a training program that would meet its unique requirements.

The agenda for the workshop is presented in Appendix A. Preliminary remarks were made by a representative of the FAA, the chairmen of the training committees of the Air Transport Association, Air Line Pilots Association, and Allied Pilots Association, and by the Vice President, Air Safety and Engineering, of the Flight Engineer's International Association. The NASA presentation that followed focused upon issues that had been identified on the basis of discussions with various people and observations made during field trips to airline training centers by the authors; those issues form the basis of this report. The remainder of the first day was devoted to a series of presentations and general discussion by the carriers who are currently conducting LOFT according to AC 120-35 or who have developed and conducted alternative approaches and/or evaluation studies of the concept.

Following a general discussion of issues raised by the preceding presentations, assignments and instructions were given to the four working groups whose individual reports provide the foundation for the remaining chapters of this report. Working group assignments and specific instructions can be found in Appendices B and C.

All of Day 2 and the early part of Day 3 were spent in individual working group meetings and in the preparation of the draft working group reports. On the third day, a plenary session was held during which the working groups presented their individual reports. Questions and discussion followed each report, and after a general discussion and closing remarks the workshop was adjourned.

This volume of the conference proceedings is devoted to a presentation of the guidelines for LOFT, as developed from materials by the working groups during the workshop. The authors used the draft working group reports, appropriately amplified, reorganized, and rewritten for editorial consistency to form the major parts of Chapters III through VI. Chapters I, II, and VII were written by the authors, using material in the working group reports and other material presented at the workshop. The reader will note some redundancy between chapters. This is a result of the interrelationship of many of the factors associated with LOFT; it also allows readers interested only in certain aspects of LOFT to peruse those sections of interest without a significant loss of understanding. This report has been reviewed by all workshop participants, and was revised to reflect their commments.

In view of possible regulatory changes regarding LOFT, participants in the workshop (listed in Appendix D) were urged to address the issues without regard to current Federal Aviation Regulations (FAR) or AC 120-35. Every attempt was made to ensure that the guidelines that follow were developed on the basis of technical issues, not on the basis of what may or may not be required by the FARs, either now or in the future. Because of this attempt, and because of the wide variety of carriers, organizations, and agencies represented, it is believed that this report accurately reflects the current state-of-the-art with respect to LOFT.

The present volume contains only the guidelines. Volume II of these proceedings contains supporting and background material, including copies or transcripts of the various presentations and discussions occurring on the first day of the workshop, the draft working group reports, and transcripts of the questions and discussion of these reports. The interested reader is urged to consult Volume II for a supplementary discussion of LOFT and related issues.

CHAPTER II: DEFINITION OF THE LOFT CONCEPT

Introduction

The use of full-mission, or line-operations simulation in pilot-training programs is a technique that has evolved over many years. When the state of simulation technology had developed to the point at which the systems operations and handling qualities of a particular simulator were recognizably like those of a specific airplane, when various ground facilities, including navaids and airports could be simulated, and when the development of visual-scene-generation-technology allowed the simulation of visually referenced operations, all the necessary ingredients existed for conducting line-operations simulation.

This technology made possible the use of simulation to teach not only systems knowledge, operating skills, and aircraft-handling skills, but also the crew-coordination, decisionmaking, leadership, and management skills, which are important elements of the airline pilot's job. Exigencies and contingencies encountered during "routine" line operations could now be simulated, and, under the controlled, safe situation provided by the simulation environment, pilots could exercise these "high-level" skills in ways that previously could be accomplished only in actual line operations.

There have been several approaches to the augmentation of simulator training programs via the use of line-operations simulation, including a program conducted by the United States Air Force Strategic Air Command. However, the most concerted effort, which led to a change in the FARs, occurred during 1974-75. In mid-1974, Northwest Orient Airlines had a task force at work on a program known internally as Coordinated Crew Training (CCT). Recognizing that CCT met certain training objectives that were not being effectively achieved by recurrent training programs conducted under FAR 121 Appendix F, Northwest petitioned the FAA for an exemption to permit a one-year test and evaluation of this training concept. The exemption was granted in February, 1976. On the basis of the positive results observed at Northwest, the FAA issued an additional exemption in October, 1977, which allowed other air carriers to utilize LOFT on a voluntary basis. Finally, in May 1978, Advisory Circular AC 120-35 was published, and FAR 121 was amended to permit LOFT to be utilized in any airline recurrent training program.

Since that time, several airlines have implemented LOFT as embodied in AC 120-35 (five airlines as of January, 1981). Others have evaluated the concept and have taken steps to implement LOFT programs in the near future. Still others have evaluated the concept and, for various reasons, have decided

that LOFT, as defined in the advisory circular, does not meet their requirements. Problems cited by these carriers include scheduling, instructor number and qualifications, economic costs, and in some cases, concern with the effectiveness of LOFT as a method of recurrent training, particularly manual skills training. For a good summary of these concerns, the reader is referred to the "Remarks" by Capt. A. A. Frink which are reprinted in Volume II of these proceedings. One of the major objectives of this workshop was to review those issues and to develop flexible guidelines which would enable any operator to utilize LOFT to meet his unique requirements.

Discussion of Relevant Research

NASA involvement and interest in LOFT stems largely from some early work conducted under a Human Factors in Aviation Safety Program. One major study conducted under that program was done by Ruffell Smith and colleagues during 1975-76 (ref.#1). This study utilized an airline training simulator and highly structured trip scenarios as a means of examining human error in flight operations. Ruffell Smith and his coworkers were interested in measuring the frequency and kinds of errors in simulated line operations and determining the circumstances under which these errors were committed.

One of the earliest observations made during that study was that there may be considerable potential for augmenting air-carrier pilot-training programs through the use of this full-mission, or line-operations, simulation. Specifically, it was observed that line-operations simulation seemed to provide a vehicle for demonstrating the importance of effective cockpit resource management, and it provided crews with vivid demonstrations of operational complications that can result when resources are ineffectively or inappropriately utilized.

These preliminary observations and conclusions were further strengthened when the NASA researchers learned of the work being conducted by Northwest. Cockpit resource management training was the subject of a NASA/Industry workshop in June, 1979. On the basis of the earlier work at Northwest and NASA, and on the basis of the experience with LOFT as described by Eastern Airlines at that conference, it was recognized that LOFT provided an important tool for conducting cockpit resource management, leadership, and command training. Further details of the proceedings of that workshop can be found in reference 2.

Definition and Description of LOFT

With any new or developing technology, problems with nomenclature and the definition of terms can arise. Selection of appropriate terminology and definitions is an important process--discussions can become hopelessly confusing if terms

are used imprecisely or if they are poorly or inappropriately defined. Although the problem of terminology was discussed at some length at the workshop, and several proposals were made with regard to definitions, terms, and acronyms, no consensus was reached. Further attention to the problem has resulted in the development of the following definitions:

1. Line-Oriented Flight Training (LOFT): refers to the use of a training simulator and a highly structured script or scenario to simulate the total line operational environment for the purposes of training flight crews. Such training can include initial training, transition training, upgrade training, recurrent training, and special training, e.g., route or airport qualification training. The appropriate term should appear as a prefix with LOFT, e.g., "Recurrent LOFT," to reflect the specific application.

2. Line-Operations Simulation (LOS) is synonymous with the term "full-mission simulation," but LOS avoids the other misleading and irrelevant connotations of "mission." LOFT, then, is the use of LOS for training purposes. Any other use of LOS should be expressly stated. For example, LOS can be used to aid in the development and evaluation of operating procedures and new equipment, proficiency checking, pilot selection for new-hire programs, or cockpit human factors research.

Essential Features of LOFT

A complete discussion of the essential features of LOFT is presented in Volume II of these proceedings. The following quotations from this discussion during the first day of the workshop reflect many of the characteristics of LOFT that distinguish it from other forms of simulator training:

"LOFT is a line environment flight-training program with total crew participation in real-world incident experiences, with a major thrust toward resource management." (Capt H. T. Nunn)

"...line-oriented flight training, in principle, has filled a long existing need in airline-crew training, that of command and resource management in the total crew resolution of realistic line-type problems." (Capt. A. A. Frink)

The features that characterize LOFT are as follows:

1. LOFT is the application of line-operations

simulation to pilot-training programs. LOFT is a combination of high-fidelity aircraft simulation and high-fidelity line-operations simulation.

2. LOFT involves a complete crew, each member of which operates as an individual and as a member of a team just as he does during line operations.

3. LOFT involves simulated real-world incidents unfolding in real time. Similarly, the consequences of crew decisions and actions during a LOFT scenario will accrue and impact the remainder of the trip in a realistic manner.

4. LOFT is casebook training. Some problems have no single, acceptable solution; handling them is a matter of judgement. LOFT is training in judgement and decisionmaking.

5. LOFT requires effective interaction with, and utilization of, all available resources; hardware, software, and "liveware," or the human resources. A LOFT scenario requires the exercise of resource management skills.

6. LOFT is training. LOFT is a learning experience in which errors will probably be made, not a checking program in which errors are not acceptable. The purpose of LOFT is not to induce errors, but cockpit resource management is, in part, the management of human error. Effective resource management recognizes that under some circumstances, such as high-workload situations, human error is likely; steps must be taken to reduce the probability of error. However, it is also necessary to maximize the probability that error, when it does occur, will be detected and corrected, thereby minimizing the probability of adverse impact upon the overall safety of the operation. Just as it is necessary to practice landing skills in order to gain and maintain aircraft-handling proficiency, it is necessary to practice human-error-management skills; the former requires a simulator or airplane, and, the latter, the presence of errors or error-inducing situations.

Limitations of LOFT

Although LOFT may fill an important training need, the potential user of LOFT must recognize that LOFT is not a panacea for all training problems. LOFT is resource management training, but, as pointed out frequently in the proceedings of the resource management workshop, one of the absolute

prerequisites of effective cockpit management is a highly skilled, highly knowledgeable pilot. Proficiency in manual control of the aircraft and in the operation of its systems is primary--without it, no amount of management, command, or leadership training will produce a safe, proficient, and effective pilot. Therefore, LOFT can be effective only in the context of a total training program that ensures that basic skill and knowledge requirements are met. This total program must be based upon the unique requirements of an airline, a fleet of aircraft, a crew, or an individual crew member. Furthermore, these requirements are not static. For these reasons, LOFT must not be viewed as a training program, but rather as a tool that can contribute to the overall objectives of such a program. LOFT is not a replacement for maneuver-oriented flight training, or "batting practice" as it has been called. When both are combined in proportions determined by the unique requirements of the carrier, a more effective total training program will result.

CHAPTER III: GUIDELINES FOR THE DESIGN AND DEVELOPMENT OF LOFT SCENARIOS

Introduction

The design and development of scenarios for LOFT programs require considerable attention to the needs of the particular carrier. Different air carriers, different operations within a carrier, and different pilots within an operation all have various types of training needs. It is essential that considerable flexibility be permitted in order to meet these various training requirements.

The design and development of a LOFT program should be guided by a consideration of the skills required of an individual pilot, as well as the skills necessary for a fully integrated flight crew, such as crew coordination and cockpit resource management. A well-designed LOFT scenario will exercise both sets of skills. LOFT is also a good vehicle for providing experience with problems in aviation operations such as distraction, complacency, forgetting, and failure of information transfer.

These guidelines deal mainly with Recurrent LOFT, but the LOFT concept may be utilized in areas other than recurrent training (see Chapter VII). Although these other applications are not considered in this chapter in detail, most of the guidelines for scenario design and development discussed in this chapter are appropriate for other uses of LOFT and LOS (as are the guidelines in other chapters). The major consideration governing the use of LOFT for any operation is the specific objective for which it is being used and the situational context in which it is being applied. The latter requires a painstaking amount of attention to the variables within an operation. All LOFT scenarios and flight segments should be designed on the basis of a formal and detailed statement of specific objectives and desired end products. For example, if a carrier is experiencing an unusual frequency of a specific operational problem, such as problems with wet or icy runways, then the LOFT scenarios should be designed to include that particular operational problem. Other specific objectives could include maintenance of CAT II qualifications, winter-operations training, unusual airport or runway operations, or pilot-incapacitation training. The process of defining specific objectives for LOFT and LOS is an important first step because it encourages serious thought about the factors that should be incorporated in a particular scenario.

Origin, Routing, and Destination

The origin, routing, and destination of a particular scenario is dictated by the specific training needs arising from the route structure of a carrier. Operators typically flying short-haul routes will need substantially different scenarios than those serving long, nonstop routes. Other factors for consideration are the weather, climate, and other environmental factors. Some carriers, presently conducting LOFT programs, have utilized weather information from actual days along a trip route. Simulator visual and other capabilities and limitations must be accounted for, or worked around, at a very early stage of scenario design and development.

The simulator navigation area must be appropriate to the route selected and should coincide precisely with current navigation and approach charts. It has been pointed out that the major advantage of LOFT is realism, but much of this realism is lost if the scenarios are not consistent with a carrier's route structure or if the crew is unable to use actual charts, manuals, and other materials. In many cases, it may be feasible to use actual trip sequences for LOFT scenarios.

Other factors for consideration are alternate airports, fuel, and air-traffic-control situations. It cannot be overstressed that the specifics of location choice depend entirely on the training needs and route structure of the carrier. For example, if a carrier is experiencing air-traffic-control problems in a certain location, it would, of course, be advantageous to construct a scenario around those problems and to choose a route where those problems are most likely to occur.

Abnormal and Emergency Conditions

Problems and anomalies should also be chosen on the basis of the specific objectives of a given LOFT scenario. Problems can be roughly categorized into two types. The first consists of simple problems--those that have no further impact on the conduct of the flight once they have been diagnosed and corrected, e.g., a hung start or a potential hot start. The second type is a complex problem--one that cannot be corrected in flight and continues for the duration of the flight, e.g., a failed essential A.C. bus. It is desirable to utilize both problem categories in designing LOFT scenarios, however, the overuse of simple problems in a single scenario will greatly detract from the realistic simulation of line operations. The success of a given LOFT scenario is heavily dependent upon creating and sustaining an illusion of reality. The use of frequent, simple, or unrelated problems such as hung starts, stuck start valves, hot starts, and similar types of problems

will cause many pilots to feel that they are "back in the box for a check."

Problems should not be made unncessarily complex. The simultaneous presentation of multiple problems is somewhat unrealistic and should not be routinely designed into scenarios, although multiple problems may develop as a result of inappropriate crew actions. LOFT should not incorporate the notion of "burying" the crew. Moreover, an "accident" should never be the inevitable outcome of a scenario, although it is always possible that one will occur. If an "accident" does occur during a LOFT session, it may provide the crew with a vivid learning experience. (See Chapter V for a detailed discussion of the topic.)

The use of problems for which there is no solution is permissible and sometimes desirable. For example, one carrier has utilized a hung main landing gear to provide a problem for which there is no solution. Some feel that the inclusion of these kinds of problems will help prevent "simulator syndrome," where crew members begin to feel that there must be a solution to all real-world problems because "they've always found one in the simulator."

Pacing, Tempo, and Quiet Periods

The pacing and tempo of a given scenario must be consistent with the location, departure time, and phase of flight, and must be in keeping with the specific objectives of that scenario. Scenario designers should avoid the continual introduction of problems such that the entire flight segment is characterized by problem solving. The design should allow for periods of relative inactivity, just as in the real world. This type of design is highly desirable because it allows crews to deal with problems from a perspective more closely approximating what would actually occur on a line trip. However, it is also necessary to incorporate segments in a scenario in which stress is generated by the sequence, pacing, and tempo of events. Learning to cope with this stress effectively is an important part of resource management training.

Generalized Scenarios versus Detailed Scripts

Experience with LOFT indicates that scripts should be as detailed as possible (see Table 1). This is an absolute necessity, because creating the illusion of the real world requires considerable attention to detail. The absence of detailed scripts leaves the LOFT coordinator largely on his own and requires him to improvise such things as the type, number, and timing of problems, and the coordination of air traffic control (ATC). In most cases this requirement would interfere with the instructor's ability to observe and evaluate the crew,

and both quality control and the value of the training experience often suffer. Communications should be scripted and utilized verbatim. The pacing and timing of the scenario should be precisely specified so that the instructor knows exactly when and how to introduce each element of the scenario. To assist the instructor, it is useful to have on the script a detailed statement of the crew's expected actions in each situation.

Subscenarios should be designed in anticipation of crew actions. In many cases, the exercise of "reasonable judgement" in an approach to a problem might permit a variety of actions. For example, if a scenario incorporates a situation in which diversion to an alternate airport, although not required, is a "reasonable" choice, then the scenario designer should plan a subscenario that covers the diversion leg. If a diversion is not desirable in a given scenario, then steps should be taken to ensure that such a decision is not likely by using weather or operational factors (e.g., closing the only open runway at the alternate). Alternatives should also be provided if the modification of scenario timing is necessary. Unexpected missed approaches, for example, might cause modifications to scenarios in order to stay within simulator scheduling constraints. Instructors need to have the flexibility to omit parts of a scenario when crew actions prolong the completion of certain legs. However, it should be understood that, despite the best efforts of the designer, it is never possible to anticipate all crew actions. For this reason, the LOFT instructor must be flexible (and creative) at all times.

The LOFT coordinator should not routinely add to or modify a scripted situation, but, if the instructor observes that a crew is overloaded to such an extent that further learning is impossible, he should be permitted to exercise reasonable judgement to prevent further compounding of the crew's situation. This can be done either by deleting planned problems, or through assistance rendered within the context of the scenario. For example, ATC might become more "helpful," company maintenance might propose a solution to a systems problem, or the dispatcher might be able to provide some useful assistance via a "SELCAL" message to the trip.

Scenario Revisions and Quality Control

After development, scenarios should be carefully tested; revisions will almost always be required. Even after testing and approval by the FAA, a scenario often will require further revision. Both the input of the LOFT coordinator and feedback from line crews is valuable in this regard. Routine coordinator meetings are beneficial and help assure continuity among the different coordinators as well as in aiding in the refinement of scenarios. In addition, crews should be encouraged to provide feedback after their experiences with LOFT.

New scenarios should be continually developed so that there is a constant turnover (new ones added as they are available and old ones deleted or saved for future use). All scenarios should be kept current with respect to navigation facilities, regulations, communications, company procedures, and aircraft modifications. Accuracy of scenarios with respect to system hardware and software is another detail essential to the credibility of LOFT.

Scenario Length

The length of a given LOFT scenario is entirely dictated by the route structure and training needs of the specific carrier. Regional carriers, for example, probably need scenarios with relatively short stage lengths. Depending on their needs, carriers may find it beneficial to structure their LOFT scenarios so that sufficient time remains in the simulator period to practice specific maneuvers or operating procedures following completion of the LOFT scenario. The proper mix of LOFT and maneuver-oriented training can be determined only on the basis of the specific requirements of the carrier, crew, equipment, and other unique factors. These factors must be considered when decisions about scenario length are made.

Candidate Problems

Problems for inclusion in LOFT scenarios can be drawn from a number of sources. Anything that can be realistically reproduced in a simulator is a candidate problem. Frequently misunderstood or misused sections of Flight Operations Manuals or Aircraft Operating Manuals can provide material for LOFT scenarios. Other sources of problems include reports from the NASA Aviation Safety Reporting System, other flight-incident reports, National Transportation Safety Board (NTSB) accident reports, and FAA Maintenance Difficulty Reports. The following list of problem categories may be useful to the scenario designer:

1. Operational Problems:

   Preflight: dispatch release, hazardous cargo, fueling options, Notices to Airmen (NOTAMS)
   Minimum Equipment List (MEL) items
   Cabin/passenger problems
   ATC problems
   Weight and balance problems

2. Environmental Problems:

   Weather, wind, temperatures
   Runways wet, icy, closed
   Runway and touchdown-zone lighting problems

3. Equipment Problems:

   Airborne equipment problems
   Ground equipment problems
      Support equipment
      Ground-based radio aids

4. Crew Problems:

   Interaction with cabin crew
   Flight-crew problems
   Incapacitation (obvious or subtle)

Table 1 shows an example of a segment of a typical LOFT scenario as it might be displayed on the instructor's working script. As can be seen, the simulator setup, communications, the weather, the timing of problem insertion, problem indications, and probable actions of the crew are graphically displayed. This format allows easy cross-reference for the instructor so that scenario timing can be closely controlled, and it greatly assists in the reduction of instructor workload.

Table 1.- Segment of a typical LOFT scenario.

PRESET CONDITIONS

FUEL _____ GW _____ ZFW _____ C.G. _____

TIME COUNT	COMMUNICATIONS	WEATHER	SEGMENT	PROBLEM INPUT	PROBLEM INDICATION	PROBABLE ACTION
	121.9 ABC maintain FL 250 ACME departure XYZ transition	10 OVC 3 70/50 1403 999	Pre-flight			
	121.9 CLRD RW 04		Start			
	118.7 CLRD T.O. left turn after T.O. CNTC DEP 119.0 airbourne		Taxi			
	119.0 Climb & Maintain FL 250 CNTC SLC Center 133.4		Climb	Duct Overheat (at FL 210)	Overheat Light	Checklist and Reset
	133.4 CNT DEN Center 132.1					
	132.1 after XYZ CLRD for DRAKO arrival. High profile descent RW 26L CLRD to descend pilots discretion		Cruise	Fail Bus Transfer Fail L. generator	Transfer Bus off & Bus off lights on	Checklist
	ATIS 125.6 BRAVO 2 OVC 1/2 75/40 2610 994 RVR 26L 2400	2 OVC 1/2 75/40 2610 994 RVR 2400				Start APU-on left bus
	132.1 CNT DEN approach 123.85 at DRAKO					
	123.85 expect radar vectors after JASIN		Descent	Left engine fire	Lights & Bell	Engine Shut-Down Fire Procedure
	123.85 descend to 9 T turn left hdg 070 slow to 170K tower 119.5		Approach	Single engine		
	119.5 CLRD to land					

CHAPTER IV: GUIDELINES FOR REAL-TIME LOFT OPERATIONS

Introduction

Of vital importance for the effectiveness of LOFT is the creation of a strong illusion of reality in the simulated trips. This requirement dictates that many individual details, such as preflight activities, trip paperwork, manuals, communications, etc., be carefully prepared. Previous experience with LOFT has shown that overlooking even the smallest detail can destroy this illusion.

Realism

All LOFT scenarios should be constructed so that they provide the highest degree of realism that is technically, economically, and operationally feasible. The more realistic the situation, the faster crews will start thinking and reacting as if they were conducting an actual line trip. If everything is designed and executed properly, this illusion of realism can be almost complete. However, there will always be a gap between the real world and the simulated world of a LOFT session. The trainee can be encouraged to help bridge this gap by "playing the game." Because of this consideration, the briefing should include mention of the role playing aspect of LOFT and its importance to overall LOFT effectiveness. When designed and executed properly, pilots participating in LOFT scenarios have actually engaged in such behavior as shining flashlights on the windshield to look for the presence of ice. Many pilots who have participated in well-conducted LOFT scenarios have commented that they virtually forgot that they were in a simulator. The obvious goal is to produce crew performance and behavior that would be typical for an actual line flight in the same set of circumstances as those developed in the scenario. In keeping with this goal, it is essential that crews have access to all the resources they would have on an actual line trip.

Briefings and Preflight Activities

It is important that crews have a complete understanding of the "rules" under which LOFT is conducted. These conditions should be presented in a thorough preflight briefing. Experience has shown that inadequate briefings set the stage for problems that later interfere with LOFT realism. The most common difficulty is convincing the crew that the LOFT coordinator is functionally not present in the simulator; that he will not be available for communication except in his role as ATC, company, maintenance, etc. The latter fact cannot be overstressed in the briefing. The philosophy underlying LOFT should be thoroughly explained before the crew begins to plan for the flight. Once

flight preparation has begun, the operations that follow should be as close to the normal pattern as is possible, given the physical limitations imposed by the use of simulation. In light of the rapid technological advances in simulation, these limitations are becoming less significant.

Adequate time must be provided for the crew to perform a normal cockpit preflight setup. If it is customary for the flight engineer or second officer to enter the cockpit before the captain and first officer, that sequence should be adhered to. However, in some cases in the interest of saving time, it is possible to modify the scenario to provide shorter ground times, such as are found on a through flight. It is desirable to provide a planned departure time toward which all preparations can be directed; this provision further enhances the realism of a LOFT scenario.

Trip Paperwork

Although an actual appearance by the flight crew in operations to pick up trip papers is not necessary, an effort should be made to duplicate as closely as possible the preflight briefing and dispatch process. The weather sequences, weight manifest, and flight plan should be identical to those provided prior to line trips; some carriers utilize actual data from past trips. All trip paperwork should be carefully constructed with definite training objectives in mind. For instance, unfavorable weather conditions, maximum weight takeoffs, or improper fuel loads can be incorporated into these materials in order to provide useful training experiences.

Communications

Communications is another area vitally important to the assurance of realism in LOFT operations. All communications must be conducted in the manner normally found on a line flight (i.e., via radio from outside the "airplane," via interphone or normal conversations between cockpit crew members, or, in the case of cabin-cockpit, via the usual aircraft equipment for this purpose). All external communications (ATC, ground crew, etc.) must be credible and realistic. Supplemental background communications are possible through the use of prerecorded cassette tapes of various ATC facilities, Automatic Terminal Information Service (ATIS), etc., and they can be channeled into the cockpit. If supplemental background radio conversation is utilized, it must be consistent with all aspects of the simulated flight and should include appropriate facilities, terminal areas, weather conditions, etc. However, cost is a definite factor with respect to the latter suggestion. If the scenarios are well planned and scripted for direct ATC communications, etc., instructors often have time to provide some background "radio chatter." Normal company communications

such as weight checks, departure reports, and inrange reports should be included. All these factors facilitate the creation of a realistic atmosphere.

The Role of the Instructor

The role of the instructor in LOFT should be viewed as that of communicator, observer, and moderator in the debriefing process; he is not an instructor in the traditional sense during the simulator period. He is the "coordinator" or manager of the flight, using appropriate radio calls or responses to direct the flight along the desired path; he must be prepared to accept and manage alternate courses of action that the crew may wish to follow. These responsibilities require a considerable amount of creativity. (It has been lightheartedly suggested that LOFT instructors may organize and affiliate with the Screen Actor's Guild!)

Most importantly, the instructor should remain as unobstrusive as possible within the physical limitations of the simulator. He should resist his temptation to "instruct;" he must not intrude in any way into the situation. The absolute lack of intrusion of any kind is very difficult for many instructors to maintain. Crews will always be tempted to initiate communication with the instructor, but the initial briefing can help circumvent many of these attempts. Experience has shown that some instructors feel that an occasional "hint" is acceptable; this is not the case. The slightest intrusion only serves to remind crews that they are in a simulator training session. Instructor training should stress this fact (see Chapter VI).

Simulator Capabilities, Features, and Limitations

State-of-the-art simulators and visual systems are capable of duplicating virtually every aspect of flight in a highly realistic manner. Several operators have recently included elaborate ground visual systems complete with gates, ramps, and taxiways. In light of these developments, and the fact that advanced simulators offer economic advantages by reducing aircraft training time, most operators will soon have all of the elements needed for highly effective LOFT training programs.

Nonetheless, certain simulator problems that cause interference with the realism associated with LOFT can and will occur. If a component required for a given scenario is inoperative, that scenario should not be flown. However, if the inoperative equipment is not required for the planned scenario (i.e., the inoperative equipment is not a vital simulator system or an MEL item) and if the crew's perception of reality is not impaired, the simulator can be used to conduct a LOFT session. Minor simulator malfunctions (instruments, etc.) can be

placarded just as the maintenance crew would do on the line. If an actual equipment failure occurs in flight and it is consistent with failures that could occur in an airplane, the scenario can proceed, with modification if necessary, just as would a line flight.

The use of certain simulator capabilities to provide replay, to be frozen, to be repositioned, etc., which are not consistent with a continuous, real-time operation should not be permitted within the LOFT context, although these features are useful for other types of training. However, some repositioning is acceptable on certain simulated long-range flights. This repositioning must be done as unobtrusively as possible, and it is best accomplished by slewing simulator position along the intended route of flight.

Inadvertent Departures from Scenarios

Despite careful planning, and regardless of the direction a flight was intended to follow, crews may elect to pursue a course of action that was not contemplated when the scenario was developed. In these instances, the LOFT coordinator has the option of permitting the selected action and supporting it with appropriate clearances, and weather, or alternatively, preventing the selected action by providing adverse weather, closed airports, or inoperative navigational aids. The latter course should be utilized with care since in many cases it is preferable to allow crews to proceed as they elect. (See Chapter III for another discussion of this topic.)

Crew Composition

LOFT should be conducted with a full crew. Regular line crews should always be scheduled, but if a scheduled crew member should not appear for the session it may be worthwhile to substitute another line-qualified crew member rather than lose the session. It is undesirable to substitute an instructor for a regular line crew member in Recurrent LOFT, particularly if the instructor is familiar with the scenario. In other specialized uses of LOFT or LOS (Chapter VII) the utilization of instructors may be acceptable.

CHAPTER V: GUIDELINES FOR LOFT DEBRIEFING, PERFORMANCE ASSESSMENT, AND FEEDBACK

Introduction

In some ways, there is an apparent conflict inherent in the discussion that follows. For maximum effectiveness, LOFT must be perceived as pure training by crewmembers and instructors alike. LOFT is learning through experience, which includes making mistakes and errors. To keep minds open, to benefit most from the experience, it is essential that LOFT be entered into with a feeling of freedom, openness, and enthusiasm. Reserve or defensiveness due to concern about "failing" must not be permitted to inhibit participation and involvement in a LOFT scenario.

On the other hand, an open, honest, constructive critique of individual and crew performance can greatly enhance the value of the training experience. Particularly when dealing with issues such as crew coordination, command, leadership, and resource management, insight into individual limitations and weaknesses is an important component of learning and training. Furthermore, everyone involved in any training program is charged with a responsibility for the continuing safety of flight operations through ensuring that the people in the system meet acceptable proficiency and performance standards. For these reasons, there is no such thing as a "no-jeopardy" training exercise. In any training program, at some point a decision is made that the trainee has progressed satisfactorily through the program; otherwise, additional training is provided. Yet it is essential to create an atmosphere in which mistakes and errors can be made without fear of failure, embarrassment or punishment. As discussed in the following section, creation of this environment is one of the most important roles the instructor plays in a LOFT program.

Role of the Instructor in LOFT Debriefing

To a considerable extent, the conflict between "training" and "checking" in a LOFT program can be offset by the manner in which the instructor sets the scene during the preflight briefing. The instructor should emphasize that:

- LOFT is designed as a pure learning experience.

- LOFT is a new training concept designed to accent command responsibilities, crew coordination, communication, and cockpit resource management.

- Mistakes may well be made, just as they sometimes occur on the line, but the crew must carry on. To some extent, LOFT is an exercise in "mistake management."

- There is frequently no book solution to a LOFT exercise--there may be no "right" solution.

- The instructor's role is to manage the training situation, not to "teach" right solutions, nor to "test" the trainees.

- There will be an opportunity for full self-analysis during the debriefing.

- The instructor will take notes only to assist in the debriefing.

Generally, these comments apply to all training programs. However, because of the nature of LOFT, other roles played by the instructor are very different from those normally played. It is critical that both trainees and instructors understand these differences. A LOFT instructor is not a "teacher" in the traditional sense of that word. As emphasized in Chapter IV, in order to achieve the highest degree of perceived realism, it is imperative that the instructor neither intervene nor intrude in any way into a LOFT scenario. Rather than actively participating in a LOFT scenario, the instructor manages it. Similarly, the role that the instructor plays during the debriefing session is primarily that of moderator. Because there are no "right" solutions to many LOFT problems, it is more important for the instructor to guide the debriefing session, so that the full range of potential approaches to the problem is explored, rather than to impose his or her ideas about how the problems should have been handled. To accomplish this, the instructor must have time to observe performance adequately. Instructors should make detailed notes of observations made during the LOFT session so that they can guide the debriefing appropriately; these notes should be used only for the debriefing.

Items for Discussion During Debriefing

Because the focus of LOFT is upon cockpit resource management skills, a LOFT debriefing session should concentrate on this area. Thus, key items for discussion include crew management, crew coordination, and crew communications. The

utilization of systems and other resources are other areas for attention. The discussion should include the use of ATC and company communications; manuals, charts, and other software; the use of other crewmembers; and the use of autopilot, autothrottle, and other potential workload-reducing devices. It is the instructor's responsibility to ensure that these items are fully explored during the debriefing session.

Self-Critique versus Instructor Critique

Experience has shown that crews frequently debrief themselves. Self-criticism and self-examination are almost always present in these situations and in many cases they are much more effective than instructor criticism. Frequently crews are more critical of themselves than the instructor would ever be. Thus, the instructor should do everything possible to foster this sort of self-analysis while at the same time keeping it at a constructive level. In his role as moderator, the instructor can guide the discussion to areas that he has noted need attention. Questions about certain procedures, decisions, and mistakes should be asked. However, unless absolutely necessary, the instructor should avoid "lectures" about what is right and what is wrong. Obviously the instructor should avoid the embarrassment of crew members as much as possible.

A suggested format for a debriefing would include:

- o A positive general statement should open the discussion.

- o Crewmembers should then be encouraged to discuss the operation both as a whole and in parts.

- o Referring to their notes, instructors must assure coverage of all aspects of the flight; no single feature should be permitted to dominate the debriefing.

- o The instructor should mention possible alternatives, different ways of accomplishing the objectives.

- o The instructor should use the question technique to develop discussion; "what if. . . ?" is a useful technique for debriefing.

- o At the appropriate time, the instructor should summarize the debriefing.

"Satisfactory Completion"

As discussed previously, everything should be done to assure crews participating in LOFT that their jobs are not in jeopardy every time they enter the simulator for a LOFT session. While "satisfactory completion" is an inescapable aspect of LOFT, at the same time it is hard to imagine "unsatisfactory training" if conducted appropriately. In some cases, LOFT may underscore areas that need extra attention, but often even serious mistakes made during LOFT are obvious to the individual crew member and need no further discussion. Even a session that results in a "crash" may be a "satisfactorily completed" LOFT session if it is evident that the crew has learned a lesson from its experience and that lesson cannot be improved upon. However, in some cases, mistakes may indicate deficiencies that do require additional work. Additional training, when necessary, could be structured to allow crewmembers an opportunity to run through the areas of difficulty in a more effective manner. An advantage of this approach is that learning may be more effective than in situations in which crewmembers are left with unpleasant memories of poor performance. The manner in which the need for additional training is conveyed to a crewmember is of vital importance and represents a challenge to companies, their instructors, and to the FAA.

During debriefing, both total crew performance and individual performances should be openly discussed and assessed by the instructor. Critical assessment of an individual can be mentioned in the presence of the full crew, but remedial details should be handled privately. Tact is required to avoid the appearance of checking rather than training.

Summary

LOFT is, first and foremost, a learning experience. The success and acceptance of a LOFT program depends in great measure on the planning and preparation for the program. Scenarios must accent realism. Instructors should be carefully selected and trained in the art of briefing, conducting the LOFT scenario, and debriefing. Additional training for crewmembers, when indicated, must be handled in a "low-key," nonthreatening manner. If these factors are carefully addressed, the implied necessity of performance evaluation and assessment will be kept in its proper perspective, will not detract from training, and should result in full crew acceptance.

CHAPTER VI: GUIDELINES FOR TRAINING AND QUALIFICATION OF LOFT INSTRUCTORS

Introduction

There is wide variance of opinion with respect to such issues as the number and qualifications of instructors. The discussion which follows represents a consensus of professional, industry, and organizational opinion, and seeks the best compromise from a training-effectiveness standpoint.

Number of Instructors

The preceding chapters have highlighted the great number of demands that the coordination of LOFT scenarios places on instructors, as well as the number of roles that an instructor must fill. Thus, many feel that LOFT training (at least for three-person crews) cannot be adequately executed with one instructor, because even though one instructor or coordinator may be able to run the scenario adequately, these demands will not leave enough time for the proper observation of performance at all three crew stations. Much of the training value is lost if the instructor has missed many of the nuances of performance for discussion in the debriefing. However, in light of the scheduling and economic constraints that would be imposed by the required use of two instructors, carriers should not be precluded from using one instructor in a LOFT program provided that appropriate steps are taken to ensure that the instructor will not be overloaded. New developments in simulator technology (i.e., programmed problem insertion) could considerably ease the burden on the instructor. Nonetheless, those implementing LOFT training sessions with one instructor should exercise even greater care in the design and construction of scenarios and scripts. Since the provision of realistic communications places a large burden on the instructor, it has been suggested that a technician could help coordinate communications in one-instructor operations. As a general rule, scenario designers should be prepared to do whatever is necessary (within reason) to free instructors for the observation of performance. If single instructors are utilized, they may need additional training in order to be properly qualified at all three crew positions.

Instructor Qualifications

LOFT, by definition, seeks to provide "line-oriented" training. For this reason, LOFT coordinators should be highly familiar with line operations. The logic underlying this assertion is that line flying is a dynamic situation, posing an ever-changing series of operational problems and considerations, that are an integral part of daily line operations. Familiarity

with these considerations is slowly lost through the lack of firsthand experience. The LOFT coordinator must be able to accurately perceive and evaluate situations as they develop. Thus, some maintain that the best way for an instructor to understand the problems and training needs of line personnel is to actually be a line pilot who maintains these qualifications by flying at least three segments as a crewmember every 90 days. A thorough knowledge of airline flight operations is a prerequisite for selection as an instructor because instructor credibility is vital to the learning process.

However, some carriers have found professional instructors, who are not currently line-qualified, to be a valuable resource. For reasons of mandatory retirement or physical disabilities, extremely capable individuals are not able to maintain line currency, but are still able to make valuable contributions in such areas as training. If an instructor is utilized who is not currently line-qualified, that person must be given an appropriate amount of ongoing training in order to remain up to date with line operational procedures and problems. It is vitally important for the nonline-qualified LOFT instructor to maintain complete familiarity with the demands upon the average linepilot. Jumpseat riding is useful for this purpose, but a professional instructor should also be given a course of recurrent training equivalent to that of the line captain. However, even more comprehensive training would be desirable since a professional instructor does not have line experience to supplement this training. One solution would be to allow these individuals to "fly" frequent LOFT scenarios as a method of maintaining some form of currency. (This solution is not desirable in Recurrent LOFT operations; see Chapter VII.)

Specialized Training for LOFT Instructors

LOFT instructors should receive rigorous training in the philosophy, principles, and conduct of LOFT. The discussion that follows addresses many of the areas that need special attention.

Previous discussion has highlighted the importance of the initial LOFT briefing. Instructors should be able to convey to their "trainees" the purpose of LOFT, create the perception that such training will be totally in keeping with line operations, and ensure the understanding that he is essentially present only to coordinate the training; not to "instruct" in the traditional sense. (The hazards of instructor intrusion cannot be overstressed!) In addition, in order to conduct the briefing, the instructor should be expert in all areas of preflight procedures, including flight plans, weather reports, minimum equipment lists, aircraft performance data, aircraft loading procedures, etc.

Training in the observation and understanding of resource management areas such as the crew concept and good crew coordination is essential. LOFT provides experience in these areas, and therefore, they represent major advantages of LOFT over more traditional types of training. As a result, the instructor must know what to look for if this advantage is to be capitalized on. (For a thorough review of the resource management area, the reader should consult the proceedings of a NASA/Industry Workshop on the subject, ref.#2.)

Instructors should be trained in the proper pacing and introduction of abnormal and emergency procedures or situations. Under normal circumstances, detailed scripts define these responsibilities, but the LOFT coordinator should understand the ways in which he can handle unforeseen crew actions (e.g., rendering navaids inoperative, closing airports because of adverse weather, etc.). The creative nature of this aspect of LOFT operation should be detailed.

The LOFT coordinator should be made aware of the importance of his own interpersonal skills as well as those of others. The instructor's own skills are necessary in order for him to properly conduct the briefing, the LOFT exercise, and the debriefing, but he must also be sensitive to these areas in others since they are strongly related to cockpit resource management abilities. A "nonthreatening" instructor is vital to the success of LOFT.

Other areas for inclusion in instructor training programs include the dimensions of performance related to the exercise of command responsibilities, crew coordination, leadership, decisiveness, and interpersonal communications. The instructor should be trained to note the level of sensitivity of each of the crewmembers toward each other. This area of training is important because a lack of sensitivity to another crewmember's responsibilities, particularly on the part of the captain, often leads to the overloading of one or more crewmembers in high workload situations. The instructor should also be aware of the importance of assertiveness, especially among subordinate crewmembers. Overbearing captains often inhibit other crewmembers from "speaking up," even in potentially dangerous situations. Of course, overassertiveness can be equally destructive and can cause breakdowns of crew coordination. Dimensions such as planning, organization, and judgement are also critical elements of proper crew coordination.

Instructors should be thoroughly familiar with aircraft systems, performance, and procedures, and they should be able to assess certain intangible assets such as flying skill and "smoothness." Knowledge of, and compliance with, FARs and ATC procedures is another area to be closely observed by instructors.

Standardization of LOFT Instructors

Differences among instructors in the ways they conduct LOFT can lead to wide variations in the effectiveness of the exercise. Briefings and debriefings may be conducted in vastly different ways, and inconsistencies in performance assessment can occur. This problem is the partial result of the inadequate training of instructors in LOFT concepts, and it can be alleviated if LOFT coordinators are given a complete training program at the outset, followed by frequent and systematic monitoring by supervisory personnel. Feedback and critique from line crewmembers are invaluable for an effective instructor-standardization program, as well as for the overall LOFT program.

LOFT standardization will also be enhanced if instructor/coordinators are encouraged to monitor each other. Obviously, standardization is easier if the LOFT coordinator group is relatively small and if they work almost exclusively on the LOFT program, but this approach may not be practical for all potential users. Nonetheless, regularly scheduled standardization meetings should be held. During these sessions, operational difficulties can also be addressed. Complete standardization will never be achieved (and is not necessarily desirable), but these steps will facilitate a high degree of uniformity among instructors.

CHAPTER VII: OTHER USES OF LOFT AND LINE-OPERATIONS SIMULATION

Introduction

The focus of the previous discussion has been upon Recurrent LOFT. The purpose of this discussion is to explore other uses of LOFT and to look at other potential applications of LOS. However, because most of the experience to date has been with Recurrent LOFT, much of what follows is intended to suggest possible avenues for exploration rather than to present guidelines.

Other Uses of LOFT

Training applications of line-operations simulation include initial or new-hire training, transition training, upgrade training and special training programs. Each of these is discussed briefly below.

Initial training- Because of its orientation, Initial LOFT might provide an excellent introduction to line operations for the new-hire pilot or flight engineer. Because of its emphasis upon integrated, coordinated crew operations, Initial LOFT would seem to provide the most benefit as the capstone of an initial or new-hire training program. The Initial LOFT scenario should be designed so that the new-hire is required to exercise all the individual skills and knowledge areas developed earlier in the training program. Thus, scenarios developed for Initial LOFT should be designed so that the focus is largely upon the newly hired crew member, depending on what role the new-hire will fill (e.g., first officer in two-pilot operations, second officer or flight engineer in three-pilot operations). Furthermore, since this is part of an initial training program, emergency and abnormal situations should be deemphasized. The scenario should highlight "normal" line operations and the way in which the new-hire should function as a team member. Initial LOFT would be a good vehicle for introducing the new crewmember to the myriad distractions that can occur in normal line operations. The new-hire must learn to recognize various demands being placed upon him or her, to assign priorities to those demands, and then to proceed in an orderly fashion to complete the various tasks competing for his or her attention. The new-hire can also be exposed to situations that require monitoring of other crewmembers and making appropriate callouts in accordance with standard operating procedures. Learning when to "speak up" in the cockpit is an important process. Initial LOFT scenarios can be designed to force situations in which "speaking up" is highly desirable.

Because the emphasis of Initial LOFT is upon an individual crewmember (albeit functioning as a team member), it is probably

not necessary to use a full line crew in these scenarios. As long as the individuals in the other seats play appropriate roles, these crew members could be LOFT instructors rather than regular line pilots. This allowance does not relax the requirement that these instructors be completely familiar with line operations, however. It is also possible that these Initial LOFT programs could be integrated with LOFT instructor training, thus meeting a dual purpose of maintaining instructor qualifications for LOFT and completing the new-hire training process.

Transition training- Much of the discussion about Initial LOFT also applies to Transition LOFT. Again, the focus is upon an individual functioning as a member of a team. The scenario should be designed to exercise crew coordination, communications, and management skills, and it should emphasize unique characteristics and features of the aircraft to which the trainee is transitioning. For example, if the trainee is transitioning from other equipment to a current-generation wide-body aircraft, the LOFT scenario might be designed to require extensive operation, both normal and abnormal, of the autopilot and flight-guidance panel.

Transition LOFT scenarios should be designed to emphasize normal line operations initially. If abnormal and emergency situations are introduced, they should either be introduced late in the scenario or be placed in a separate scenario. Again, since the emphasis is upon an individual trainee, it is probably not necessary to use a complete line crew for Transition LOFT.

Upgrade LOFT- LOFT would seem to be particularly valuable for upgrade training, especially because of the emphasis upon command, leadership, and resource management. Upgrade LOFT scenarios should emphasize situations in which effective command and unambiguous communications are required. These scenarios should force the trainee to recognize conflicting task demands, set priorities, and ask for assistance or delegate responsibilities when necessary. Upgrade LOFT is of particular importance for upgrading captains. Because this situation may be the first opportunity for the new captain to exercise resource management skills, it is important to structure the Upgrade LOFT scenario to thoroughly exercise these skills.

Special LOFT- Line-operations simulation can be used for any training that requires coordinated crew performance. Examples might include: (1) engine-out ferry training and qualifications (this could be an actual preview of the equipment and route for the ferry flight); (2) charter-operations qualifications (this could be either a preview of a specific charter trip or generalized charter-operations training); and (3) remedial training for pilots, particularly for pilots having command, leadership, or resource management problems.

Summary- As indicated previously, any training program that involves coordinated crew operations might benefit from the application of line-operations simulation. Training that focuses upon specific systems or flight-control skills, including wind-shear problems, high-altitude stalls, development of takeoff and landing skills, and similar component skills, is probably not amenable to the use of LOS. These problems are "batting practice" problems, and the introduction of other requirements such as, crew coordination, etc., would only serve to distract attention from the specific problem being trained. However, manuever competency is, to a large extent, a reflection of good crew coordination, and this relationship cannot be ignored. As pointed out in Chapter II, LOFT is not a panacea. The decision to use LOFT must be based on a consideration of the specific objectives desired for the training program. Part-task training will continue to be a major element of a total training program.

Other Uses of Line-Operations Simulation

Because line-operations simulation provides a highly realistic, dynamic environment for flight crews, LOS can be used in any application in which the objective is to determine total aircraft-pilot system performance and the effects of changes in hardware, procedures, or people upon that performance. Perhaps the best examples are in the area of evaluation. LOS can provide a very effective tool for evaluating and developing operating procedures, checklists, aircraft-operating manuals, charts, and other system software. Users of LOFT were surprised to discover deficiencies in certain abnormal or emergency procedures as a result of difficulties observed during LOFT scenarios. Thus, it may be beneficial to check out thoroughly any changes in procedures by observing how they actually work during suitably designed line-operations simulation scenarios. For example, the development and evaluation of new fuel management techniques may be a good candidate for LOS.

The same observations apply to the evaluation of new hardware in the cockpit. The final stage of evaluating new hardware and its integration into an existing cockpit might include a LOS scenario. Problems associated with the operation of the new equipment or changes in the amount or distribution of workload among the various crewmembers will become apparent in a LOS scenario when they might otherwise remain undetected. It is interesting to speculate whether or not the early experiences with the Ground Proximity Warning System might have been different had the system been thoroughly evaluated by LOS prior to its introduction into line service. Similarly, LOS may play an important role in putting the new-generation of electronic-cockpit aircraft into operational service.

LOS has been utilized by at least one carrier to conduct proficiency checks. As advanced simulators continue to replace the aircraft as a training and checking tool, line checks in the simulator may become commonplace. However, this use of LOS may require an even greater emphasis on "normal" line operations.

Finally, mention must be made of the use of LOS in human factors research. Any research issue that involves the performance of individuals and crews during line operations is a candidate for LOS. Examples include the effects of pilot fatigue, distraction, complacency, high workload, and other factors. Also, LOFT and LOS provide excellent opportunities to evaluate new pilot training programs. The Ruffell Smith study demonstrated the effectiveness of LOS for human factors research.

APPENDIX A

NASA/INDUSTRY WORKSHOP ON LINE-ORIENTED FLIGHT TRAINING

January 13, 14, and 15, 1981

Ames Research Center
Moffett Field, California

Day 1

0830	Welcome and Overview
0845	FAA and Industry Comments
0900	Full-Mission Simulation and its Application to LOFT
0945	Coffeebreak
1000	Industry Presentations on LOFT (NW, FL, and UA)
1215	Lunch
1300	Industry Presentations on LOFT, continued (EA, TI)
1430	Coffeebreak
1445	Industry Presentations on LOFT, continued (DL, AA)
1615	Industry Comments and Discussion
1715	Working-Group Instructions
1730	Adjourn

Day 2

All Day: Working Group Meetings

Working Group I: Guidelines for LOFT Scenario Development
Working Group II: Guidelines for Conducting LOFT Scenarios
Working Group III: Guidelines for Performance Assessment and Debriefing
Working Group IV: Instructor Training and Qualification

Day 3

0830	Working-Group Meetings
1000	Plenary Session: Working Group Reports
1200	Adjourn

APPENDIX B

LOFT WORKSHOP: WORKING-GROUP ASSIGNMENTS

WORKING GROUP #1
TOPIC: LOFT SCENARIO DEVELOPMENT

CHAIRMAN: Peter Sherwin OZ
VICE CHAIRMAN: Charlie Billings NASA

MEMBERS:

Bill Edmunds ALPA
Wally Erickson TW
Charles Hunt FEIA/AA
Neil Johnson UA
Ed Karabella, Jr. FM
Tom Nunn NW
Bill Reichert PA
R.N. Smith APA

WORKING GROUP #2
TOPIC: LOFT REAL-TIME OPERATIONS

CHAIRMAN: Dale Cavanagh UA
VICE CHAIRMAN: Bob Randle NASA

MEMBERS:

Bert Beach EA
Wayne Disch TW
Kevin Gallagher FM
Jim Michaels APA
Ernie Rischar CO
Dick Norman ALPA/PA
Gerry Norton WC
Don Thielke FEIA/AA

WORKING GROUP #3
TOPIC: PERFORMANCE ASSESSMENT AND FEEDBACK

CHAIRMAN: Al Frink PA
VICE CHAIRMAN: Clay Foushee NASA

MEMBERS:

Arnold Atkatz AL
Dave Devine TI
Charles King FEIA/AA
Don Jensen AA
Ken Warras ALPA/NW
Jay Whitehead DL
Roy Williams FL
Kip Wintenburg CO

WORKING GROUP #4
TOPIC: INSTRUCTOR QUALIFICATIONS AND TRAINING

CHAIRMAN: Ron Sessa AL
VICE CHAIRMAN: Ren Curry NASA

MEMBERS:

Walt Estridge AA
Roger Fleming ATA
Jim Hardy EA
Roland Liddell ALPA/TW
Jim Sifford PI
Jack Somerville TI
Ed Steger WC
Bill Traub UA

APPENDIX C

INSTRUCTIONS FOR WORKING GROUPS

It is our intent to publish the proceedings of this workshop in the form of a handbook of guidelines for the conduct of LOFT. A proposed outline is attached. To be useful, this document must contain sufficient information to allow any company involved in pilot training to design, develop, and conduct LOFT programs that will meet the specific and unique requirements of that company. To accomplish this, the report must be written at a level of detail that will provide useful guidance and yet not preclude sufficient flexibility to allow a user to tailor a LOFT program to meet the unique requirements of his operation, equipment, routes, crews, instructional staff, simulation facilities, and other factors. Keep in mind that you and your colleagues at other carriers will be the ultimate consumers of this report.

Each working group has been assigned a specific topic area for discussion. Please focus your deliberations on the assigned area. However, we do not mean to preclude consideration or discussion of the other areas. It is expected that each group will reach some conclusions about each topic area, and we encourage you to include these in your reports. NASA will assume the responsibility for editing and integrating the final report, so don't worry about overlap or duplication.

In addition to the four major topics assigned to individual working groups, there are three chapters for which no specific responsibility has been assigned. Because these chapters, particularly Chapter II: Definition of the LOFT Concept and Chapter VII: Other Uses of LOFT, are more general than the others, we are asking all working groups to include, whenever possible, these areas in their deliberations.

We have allowed a full 1-1/2 days for individual working group meetings. We have also made typing services available. Both were done in the interest of promoting reasonably extensive, detailed working group reports. Obviously, it is not possible to write a complete draft report by committee in a day and a half. However, to ensure accurate reflection of the discussion and conclusions reached by each group, you are strongly encouraged to generate sufficient written detail so that we can generate a first draft of your chapter after the workshop. For example, it would be most helpful if your working group report could contain a complete outline of your chapter and a short paragraph for each chapter subheading.

Each working group will be given an opportunity to summarize their deliberations and conclusions on Thursday afternoon, followed by a general discussion.

After the workshop, NASA will prepare a draft report, which will then be distributed for review and comment prior to publication. We are committed to producing preliminary copies of this report for distribution to each of the participants within 10 weeks of the workshop. To achieve this, your cooperation in generating as much written detail as possible during the workshop is vital.

LOFT Workshop Participants

NAME	TITLE	CARRIER/ORG.
Capt A. Atkatz	Check Pilot	USAir
Capt B.E. Beach	Manager-Intermediate Jet Training	Eastern Air Lines
Mr. D. Beaudette	Chief, Training & Technical Stand. Br	Federal Aviation Administration
Capt D. Cavanagh	Director-Flight Standards & Procedures	United Air Lines
Capt D. Devine	Check Pilot	Texas International Air Lines
Capt W. Disch	Manager-Flight Instruction Standards	Trans-World Air Lines
Mr. W. Edmunds, Jr.	Human Performance Specialist	Air Line Pilots Association
Capt W. Erickson	Manager-Flight Training 707/727	Trans-World Air Lines
Capt W.W. Estridge	Director-Flight Training	American Air Lines
Mr. J.R. Fleming	Assistant V.P.-Operations	Air Transport Association
Capt A.A. Frink	Vice President-Flight Training	Pan-American World Airways
Capt K. Gallagher	B-727 Flight Instructor	Federal Express
Capt J.D. Hardy	Manager-B-727 Flight Training	Eastern Air Lines
Mr. C. Huettner	Ass't Chief, Air Transport Div.	Federal Aviation Administration
Mr. C. Hunt	Member, FEIA Training Committee	Flight Engineers Int'l. Assn.
Capt D. Jensen	Check Airman-B727	American Air Lines
Dr. N. Johnson	Flight Training Development Specialist	United Air Lines
Capt E. Karabella, Jr.	Manager-DC-10/B-727 Flight Training	Federal Express
Mr. J. Lewis	Member, FEIA Training Committee	Flight Engineers Int'l. Assn.
Capt R. Liddell	Pilot Training Committee	Air Line Pilots Association
Capt J. Michaels	Chairman, Training Committee	Allied Pilots Association
Capt R. Norman, Jr.	Chairman, Pilot Training Committee	Air Line Pilots Association
Capt G. Norton	Chief Pilot	Wien Air
Capt H.T. Nunn	Director-Flight Training	NorthWest Orient
Capt W. Reichert	Director-Flight Standards & Training	Pan-American World Airways
Capt E. Rischar	Instructor-Flight Standards & Training	Continental Air Lines
Capt R.M. Sessa	Vice President-Flying	USAir
Capt P. Sherwin	Director-Flight Standards & Training	Ozark Air Lines
Capt J. Sifford	Director-Flight Standards	Piedmont Air Lines
Capt R. Smith	APA Training Committee	Allied Pilots Association
Capt J. Somerville	Standardization Check Pilot	Texas International Air Lines
Capt E. Steger	Check Pilot	Wien Air
Mr. D. Thielke	V.P.-Air Safety & Engineering	Flight Engineers Int'l. Assn.
Capt W. Traub	Director-Flight Operations & Training	United Air Lines
Capt K. Warras	Pilot Training Committee	Air Line Pilots Association
Capt J. Whitehead	DC-9 Program Manager	Delta Air Lines
Capt R. Williams	Director-Flight Training	Frontier Air Lines
Capt K. Wintenburg	Flight Instructor	Continental Air Lines

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16. Abstract

Line-Oriented Flight Training (LOFT) is a developing training technology which synthesizes high-fidelity aircraft simulation and high-fidelity line-operations simulation to provide realistic, dynamic pilot training in a simulated line environment. LOFT is an augmentation of existing pilot training which concentrates upon command, leadership, and resource management skills.

This report, based on a NASA/Industry workshop held in January, 1981, is designed to serve as a handbook for LOFT users. In addition to providing background information, guidelines are presented for designing LOFT scenarios, conducting real-time LOFT operations, pilot debriefing, and instructor qualification and training. The final chapter addresses other uses of LOFT and line-operations (or full-mission) simulation.

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